ENCLOSURE 2

SHINE TECHNOLOGIES, LLC

SHINE TECHNOLOGIES, LLC REGULATORY ENGAGEMENT PLAN FOR THE USED NUCLEAR FUEL RECYCLING PILOT FACILITY

REGULATORY ENAGEMENT PLAN
(PUBLIC VERSION)

8 pages follow

1. PURPOSE

The purpose of this Regulatory Engagement Plan (REP) is to guide interactions and enhance communications between SHINE Technologies, LLC (SHINE) and the U.S. Nuclear Regulatory Commission (NRC) during pre-application activities that support the licensing of a proposed pilot facility for the recycling of used nuclear fuel (UNF). The overall goal of the REP is to describe the planned interactions between SHINE and the NRC staff that will ultimately support future regulatory decisions.

The specific goals of this REP include outlining a plan with the following activities:

- Ensuring early engagement and clear communication between the NRC and SHINE to address any questions or concerns early in the project.
- Gaining alignment on regulatory strategy, including applicable regulations, necessary exemptions, and NRC review approach.
- Communicating the expected project schedule to assist in planning for necessary resources and support a timely NRC review.
- Informing the NRC staff of the basic technical details of the UNF recycling pilot facility.

This REP covers anticipated pre-application engagement activities between SHINE and the NRC staff aimed to establish open communication and minimize regulatory uncertainty in the licensing process. This REP is expected to be a living document and will be updated periodically as plans evolve to support future licensing actions and regulatory decisions. Changes to this REP will be communicated to the NRC staff via formal letter. The format and content of this REP is informed by NEI 18-06, “Guidelines for Development of a Regulatory Engagement Plan.”

1.1 Contact Information

The SHINE point of contact for the UNF recycling pilot facility project and coordination of interactions between SHINE and the NRC staff is the Senior Director of Licensing and Regulatory Affairs, at the following address:

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2. TECHNOLOGY SUMMARY

2.1 Project Goals and Objectives

The project goal is to construct and operate a UNF recycling pilot facility that demonstrates the technology and economics necessary for UNF recycling to be viable in the U.S. By harvesting the usable materials from the UNF, including uranium and plutonium for new mixed oxide (MOX) and recycled uranium (Rec-U) fuel and valuable fission product isotopes, the volume and toxicity of waste from the UNF is greatly reduced. SHINE also intends to harvest the actinides for sale or future destruction through transmutation, further reducing the toxicity and longevity of the remaining waste.

The UNF recycling pilot facility has a planned throughput of up to 200 metric ton of initial heavy metal (MTiHM) per year.

2.2 Process Overview

SHINE has selected a liquid-liquid extraction process that maintains a fraction of the uranium (U) with the plutonium (Pu) for proliferation resistance. A high-level overview of the separation process is provided in Figure 1.

The separation process will begin with conventional shearing of fuel rods to expose the fuel pellets. The resultant pellets and hulls will be subjected to a voloxidation process to remove volatile radionuclides from the process stream. This material will then be dissolved in nitric acid, clarified of particulate matter, and moved into a co-decontamination (CoDCon) separation process to generate U/Pu/neptunium (Np) and U output streams. The primary output of this step is moved to an actinide lanthanide separation (ALSEP) process to isolate the minor actinides for future transmutation. The raffinate from the ALSEP process is sent to a fission product capture step, where valuable stable and radioactive elements are harvested. The remaining raffinate is solidified and packaged as waste, either via vitrification or cementation depending on the final waste categorization.

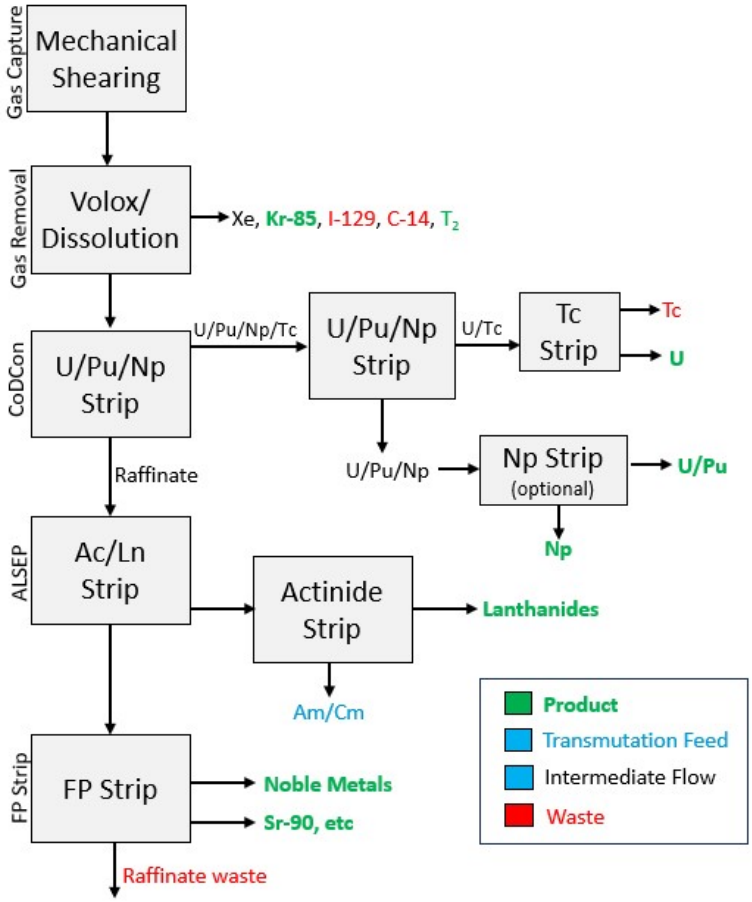

Figure 1: High-Level Process Flow in UNF Recycling Pilot Facility

The voloxidation process is used to convert the uranium dioxide (UO_2) in UNF to triuranium octoxide (U_3O_8) or uranium trioxide (UO_3). There are multiple benefits derived from voloxidizing UNF ahead of dissolution and other processing. The first of these is that it converts the material from solid pellets and pellet fragments to a coarse powder form. The increase in surface area and uranium oxidation state results in a material that dissolves much more readily in nitric acid. The second key benefit is that it releases many of the volatile fission products prior to dissolution, minimizing their contamination of downstream processes. The most significant of these are the release of tritium and iodine. Gases from both voloxidation and dissolution are directed to an off-gas system which includes treatment and capture technology to handle this waste stream.

The dissolved UNF enters the CoDCon process where the U, Pu, Np, and technetium (Tc) are removed from the raffinate. The CoDCon process is a modified version of the plutonium uranium reduction extraction (PUREX) liquid-liquid separation process and is used to separate the major actinides from the bulk dissolved UNF. A key differentiation from the PUREX process is that Pu is never separated from U, which provides increased proliferation resistance. Like all liquid-liquid separation processes, the CoDCon process relies on a series of mixing devices to induce reactions between elements in the acidic liquid and the organic liquid. SHINE intends to use a cascade of centrifugal contactors to ensure full stripping of elements from one fluid to the other.

SHINE's planned CoDCon process is broken into three primary segments. The goal of the first segment is to extract the Pu, Np, and U into the organic stream. In the second segment, the Pu and Np with a fraction of the U are then selectively stripped from the solvent with nitric acid. The third segment is stripping of the remaining bulk U into dilute acid in the third segment. The Tc can then be separated from the uranium using an ion exchange column.

The minor actinides and lanthanides represent a significant portion of the remaining used fuel and are challenging from a waste disposal perspective, as americium and curium contribute a significant amount of decay heat when considering long-term storage. These minor actinides are separated via a version of the ALSEP process. The ALSEP process is liquid-liquid separation process that can process the tributyl phosphate (TBP) raffinate directly out of CoDCon. The resultant outputs include separated minor actinides (for transmutation), separated lanthanides, and raffinate containing the balance of fission products.

Additional fission product separations are expected to include strontium-90 and noble metals (e.g., ruthenium, rhodium, and palladium) for commercial sale. Cesium is extracted during strontium separation and segregated into a separate waste stream.

Product streams include MOX, Rec-U, Np-237, Am-241, Sr-90, and noble metals. Minor actinides and potentially Tc-99, I-129, and other long-lived fission products will be stored for future transmutation. Waste streams include volatile fission product capture media, cladding and end pieces, product extraction and purification media, and solidified raffinate.

2.3 Preliminary Source Term

The pilot facility is being designed to process UNF that has a burnup of less than 35 gigawatt days (GWd) per MTiHM that has been decayed 40 years after discharge from the reactor. The resulting source terms are very low in comparison with recently irradiated fuel and minimize the risk to the health and safety of the workers and the public. In-process liquids and gases are low in comparison to total facility throughput, with waste and product streams stored in stable solid forms.

2.4 Plant Description

The main UNF recycling facility is expected to be approximately 50,000 square feet. Water and chemical consumption at the facility is minimized through acid and solvent recovery systems, which provide efficient recycling and reuse of process fluids.

3. REGULATORY STRATEGY

3.1 Application Type

SHINE intends to request issuance of a construction permit under 10 CFR Part 50 for the construction of the UNF recycling pilot facility. The UNF recycling pilot facility will be a "production facility," as defined in 10 CFR § 50.2. SHINE intends to request a Class 103 license, in accordance with 10 CFR § 50.22, for commercial and industrial facilities. The intended licensing pathway for the UNF recycling pilot facility includes the subsequent application for an operating license following the NRC review of the construction permit application.

3.2 Applicable Regulatory Guidance

The SHINE construction permit application will be developed following the format and content guidance in Regulatory Guide 3.26, "Standard Format and Content of Safety Analysis Report for Fuel Reprocessing Plants" (Reference 1). Due to the dated nature of the guidance in Regulatory Guide 3.26, SHINE intends to supplement the guidance with application guidance for other facility types, including:

- NUREG-1537, Part 1, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Format and Content” (Reference 2)
- NUREG-1537, Part 2, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Standard Review Plan and Acceptance Criteria” (Reference 3)
- Final Interim Staff Guidance Augmenting NUREG-1537, Part 1, “Interim Staff Guidance Augmenting NUREG-1537, Part 1, ‘Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Format and Content,’ for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors” (Reference 4)
- Final Interim Staff Guidance Augmenting NUREG-1537, Part 2, “Interim Staff Guidance Augmenting NUREG-1537, Part 2, ‘Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Standard Review Plan and Acceptance Criteria,’ for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors” (Reference 5)
- NUREG-1520, “Standard Review Plan for Fuel Cycle Facilities License Applications” (Reference 6)

While the above supplemental application guidance is not directly applicable to a UNF recycling facility, the application guidance represents more recent NRC staff positions on the content to be included in a safety analysis report for a production facility or fuel cycle facility, including information related to the environmental review, production facility operator training and requalification, and chemical process safety.

SHINE is continuing to review potentially relevant regulatory guidance and industry standards for applicability to the UNF recycling pilot facility. The results of these reviews will be the basis for a future interaction between SHINE and the NRC staff on the regulatory guidance to be applied in the development of the construction permit application.

3.3 General Design Criteria

The development of the general design criteria for the UNF recycling pilot facility will be informed by the following sources:

- 10 CFR Part 50, Appendix A, “General Design Criteria for Nuclear Power Plants”
- 10 CFR § 70.64, “Requirements for New Facilities or New Processes at Existing Facilities”
- 10 CFR Part 72, Subpart F, “General Design Criteria”
- Proposed 10 CFR Part 50, Appendix P, “General Design Criteria for Fuel Reprocessing Plants” (Reference 7)
- Proposed 10 CFR Part 50, Appendix Q, “Design Criteria for Protection of Fuel Reprocessing Plants and Licensed Materials Therein” (Reference 8)

3.4 Assessing Alignments/Gaps

SHINE in currently reviewing Title 10, Chapter I, of the Code of Federal Regulations, to identify applicability of the regulations to the UNF recycling pilot facility. The review is expected to result in the identification of not just the applicable and not applicable regulations, but also those regulations that may apply in part or those regulations in which exemption of the regulatory requirements will need to be sought by SHINE. The results of this review will be the basis for a

future interaction between SHINE and the NRC staff on the applicability of regulatory requirements to the UNF recycling pilot facility.

4. PRE-APPLICATION ENGAGEMENT

The SHINE pre-application strategy for engagement is focused on establishing effective communication with the NRC staff to allow for the efficient and timely resolution of key technical and licensing topics to meet project objectives. Resolution of key technical and licensing topics will reduce regulatory uncertainty and promote the development of a high-quality construction permit application by SHINE.

Accordingly, NRC engagements will be conducted in a methodical manner with alignment on objectives and deliverables, and meeting the frequency of interactions described in this REP.

4.1 Types and Frequency of Interactions

The type and frequency of interactions with the NRC will be managed by SHINE and coordinated with the NRC staff and will vary depending on the needs and availability of each. The number and frequency of these interactions will be key to maintaining a consistent understanding of the status of issue identification and resolution during the pre-application process.

SHINE plans routine interactions with NRC staff and management via project management discussions, management drop-ins, and technical discussions.

- SHINE anticipates routine project management discussions between the assigned NRC Project Manager(s) and SHINE Licensing staff to ensure timely communication of issues and consistent understanding of the status of issue resolution. These routine project management discussions will also be used to coordinate periodic management drop-ins and technical discussions. These interactions are expected to occur on a weekly periodicity.
- SHINE anticipates periodic management drop-ins between varying levels of NRC management and SHINE management to discuss non-technical topics such as the SHINE project status and schedule, as well as resolution of issues that cannot be resolved at the project management level. Such management drop-ins are expected to be non-public interactions. These interactions are expected to occur on a quarterly periodicity.
- SHINE anticipates periodic technical discussions between the NRC staff and the SHINE technical staff to support resolution of key technical and licensing topics and reduce regulatory uncertainty in the development of the SHINE construction permit application. Expected topics of these technical discussions are provided in Section 4.2 of the REP. These technical discussions may take the form of a public meeting or a pre-application regulatory audit. To support effective technical discussions, SHINE expects to make certain technical documentation available via the facility-specific online reference portal, in accordance with the information access agreement between SHINE and the NRC. These interactions are expected to occur as frequently as necessary to ensure timely resolution of key technical and licensing topics to meet project objectives.

4.2 Pre-Application Meeting Topics

SHINE proposes to conduct pre-application technical discussions with the NRC staff on the topics identified below. These pre-application technical discussions are expected to be in the form of public meetings with an opportunity for public participation, though SHINE may request a portion of these public meetings be closed to discuss information that is proprietary or otherwise sensitive. SHINE also anticipates certain technical discussions will benefit from a pre-application regulatory audit, where SHINE can make technical documentation available to the NRC staff to further their understanding of key technical and licensing topics.

- SHINE Process Overview
- Applicable NRC Regulations and Regulatory Guidance
- Construction Permit Application Content
- General Design Criteria Development
- Quality Assurance Program Description (QAPD)
- Preliminary Plans for Coping with Emergencies
- Development of the Environmental Report
- Site Selection and Site Characterization
- Approach to Radiological and Chemical Accident Analysis
- Seismic Design Methodology
- Transportation, Waste Storage, and Waste Classification

5. SCHEDULE

SHINE is currently developing a detailed schedule for the UNF recycling pilot facility project. As the detailed schedule evolves, SHINE will keep the NRC informed of key regulatory milestones, planned regulatory submittals, and specific regulatory interaction needs via routine project management discussions and periodic updates to this REP.

Currently, SHINE anticipates pre-application technical discussions between SHINE and the NRC staff related to the construction permit application to begin in calendar Q4 2023, and continue through [ ]PROP. SHINE also anticipates submitting the construction permit application for the UNF recycling pilot facility in [ ]PROP. The SHINE milestone schedule currently includes a 24-month timeframe for NRC review of the construction permit application.

6. REFERENCES

1. U.S. Nuclear Regulatory Commission, “Standard Format and Content of Safety Analysis Reports for Fuel Reprocessing Plants,” Regulatory Guide 3.26, Revision 0, February 1975 (ML003739239)
2. U.S. Nuclear Regulatory Commission, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Format and Content,” NUREG-1537, Part 1, February 1996 (ML042430055)
3. U.S. Nuclear Regulatory Commission, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Standard Review Plan and Acceptance Criteria,” NUREG-1537, Part 2, February 1996 (ML042430048)

4. U.S. Nuclear Regulatory Commission, “Interim Staff Guidance Augmenting NUREG-1537, Part 1, ‘Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Format and Content,’ for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors,” October 2012 (ML12156A069)
5. U.S. Nuclear Regulatory Commission, “Interim Staff Guidance Augmenting NUREG-1537, Part 2, ‘Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Standard Review Plan and Acceptance Criteria,’ for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors,” October 2012 (ML12156A075)
6. U.S. Nuclear Regulatory Commission, “Standard Review Plan for Fuel Cycle Facilities License Applications,” NUREG-1520, Revision 2 (ML15176A258)
7. Atomic Energy Commission, “General Design Criteria for Fuel Reprocessing Plants (10 CFR Part 50),” *Federal Register*, Vol. 39, No. 139, July 18, 1974, pp. 26293–26296
8. Atomic Energy Commission, “Design Criteria for Protection of Fuel Reprocessing Plants and Licensed Materials Therein (10 CFR Part 50),” *Federal Register*, Vol. 39, No. 139, July 18, 1974, pp. 26296–26299